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Radian Corp, Austin, Tex

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Evaluation of Particulate Sites in EPA Region VI

May 1977
Final Report

U.S. Environmental Protection Agency
Region VI
Surveillance and Analysis Division
Dallas, Texas 75270

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16 ABSTRACT

This report describes the methods and results of a quality assurance study of selected municipal and state air monitoring programs being conducted in EPA Region VI. High-Volume samplers were audited using calibrated orifice plates. The study involved a visit to each sampling station to perform a systems analysis, to evaluate the site, and to perform an audit. Data processing checks were also performed at the agency offices.

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EVALUATION OF

PARTICULATE SITES IN EPA REGION VI

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Contract No. 68-02-1383, Task Order 16

FINAL REPORT

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Surveillance and Analysis Division
Dallas, Texas 75270

May, 1977

This air pollution report is issued by Region VI Environmental Protection Agency, to assist state and local air pollution control agencies in carrying out their program activities. Copies of this report may be obtained, for a nominal cost, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia, 22151.

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Region VI Publication No. 906/9-77-001b

TABLE OF CONTENTS

		PAGE
1.0	INTRODUCTION	1
2.0	PROCEDURES	4
2.1	Equipment	4
2.2	Orifice Calibration	4
2.3	Hi-Vol Audits	5
2.4	Defects	14
2.5	Site Evaluation	15
2.6	Data Audits	15
3.0	RESULTS	16
4.0	DISCUSSION AND SUMMARY	32
	APPENDIX A - SITE EVALUATION FORMS	

LIST OF TABLES

TABLE		PAGE
2-1	Orifice Kit Calibration, Kit # 10292	6
2-2	Orifice Kit Calibration, Kit # 10377	7
2-3	Orifice Kit Calibration, Kit # 20069	8
2-4	Orifice Kit Calibration, Kit # 20070	9
2-5	Orifice Kit Calibration, Kit # 20071	10
2-6	Orifice Kit Calibration, Kit # 20072	11
2-7	Orifice Kit Calibration Data 20069	12
3-1	Hi-Vol Audit Results	17
4-1	Range of Percent Differences in Audit Results as a Function of Resistance Plate	34
4-2	Guidelines for Probe Placement	35

1.0 INTRODUCTION

This report describes the methods and results of a quality assurance study of selected municipal and state air monitoring programs being conducted in EPA Region VI. This study was performed as a part of Task Order 16 of Basic Ordering Agreement 68-02-1383. The study included high volume total suspended particulate samplers (Hi-Vols) and continuous monitors for ozone and carbon monoxide; however, this report presents only the results for the high volume samplers.

For each total suspended particulate (TSP) site, the study involved a visit to the station to perform an evaluation of the site and to perform an audit (using calibrated orifice kits) of the Hi-Vols. The state agency offices were also visited to perform data check audits for air quality data which had previously been reduced and converted to SAROAD format.

The state agencies included in the program were the following:

- Arkansas Department of Pollution Control and Ecology
- Louisiana Air Control Commission
- New Mexico Environmental Improvement Agency
- Oklahoma State Department of Health
- Texas Air Control Board

Municipal or county monitoring programs were included in the following groups:

- Albuquerque Department of Environmental Health
- Oklahoma City-County Health Department
- Tulsa City-County Health Department
- Dallas City Department of Public Health
- El Paso City-County Health Department
- Ft. Worth Public Health Department
- Galveston County Health District
- Houston Department of Public Health
- San Antonio Metropolitan Health District

Prior to initiation of the field work, each of the state agencies was visited by representatives of Radian Corporation and EPA Region VI to explain the goals of the program and the procedures to be used.

Section 2 of this report describes the methods and procedures used in this study. The results of the audit checks, station examinations, site evaluations, and data processing checks are presented in Section 3. A discussion and summary is provided in Section 4. The results of this study have been presented in a confidential manner to maintain objectivity.

The purpose of this program was to identify potential problems and areas that need improvement. The intent was not to validate data for any particular site or network as that process requires a continuing program of audit checks.

In addition to this report, Radian also provided the Environmental Protection Agency with two copies of files for each site visited. These files contain photographs, maps, and descriptions of the individual sites.

It should be noted that defects (a difference between a check value and an indicated value) as defined for this program are the best estimates available at this time, and are to be considered only as guidelines. The defects as outlined by the Environmental Protection Agency are defined in Section 2.

3.0 PROCEDURES

This section describes the procedures used during the Hi-Vol audit program. All procedures were conducted in accordance with the guidelines and criteria set forth in (1) Federal Register, Volume 36, No. 84, April 30, 1971; (2) Guideline for Development of a Quality Assurance Program (Suspended Particulate), EPA-R4-73-028b; and (3) "Guidance for Air Quality Monitoring Network Design and Instrument Siting" OAQPS 1.2-012, revised September, 1975.

3.1 Equipment

Six orifice calibration kits manufactured by General Metal Works were used during the course of the program. These kits contained the standard equipment of five resistance plates, orifice with rubber gasket, and water manometer. A General Metal Works loading adapter plate was used with each kit to connect the calibrated orifice to the adapter of the Hi-Vol. The serial numbers of the orifice kits used in this program were as follows:

10292
10377
20069
20370
20371
20372

3.2 Orifice Calibration

The first step was to verify the calibration of the orifice kits themselves. General Metal Works had previously supplied calibration data for each orifice kit. These calibration curves were verified by recalibrating the kits on the

Roots-Connerville Meter at the Texas Air Control Board. The TACB Roots meter is a positive-displacement standard and is checked against a spirometer every six months. The accuracy of this meter has been established as ± 0.5%. The orifice kits were calibrated by TACB personnel according to Federal Register procedures.

The pressure difference (inches of H_2O), atmospheric pressure (mm Hg), temperature (°C), volume flow (cubic feet), and elapsed time (minutes) were recorded for each resistance plate, and the actual flow was calculated as a function of the pressure difference. These data were corrected to standard conditions of 760 mm Hg and 298°K. The results of the calibrations for each kit are given in Tables 2-1 through 2-6. These data were used to plot calibration curves of actual flow rate versus pressure reading from a water manometer.

After the calibration curves for the orifice kits were drawn, they were individually reduced to a matrix as shown by the example in Table 2-7. The matrices were used for each audit to convert manometer readings into flow rates. This procedure thus eliminated the errors associated with curve reading and interpretation.

2.3 Hi-Vol Audits

The Hi-Vol audits were conducted according to EPA guidelines. Independent calibration checks were made on each site using the calibrated orifice kits. The EPA procedure for calibration checks consists of selecting a resistance plate and obtaining the actual flow rate. However, rather than use only one resistance plate in the orifice kit, Radian ran all five resistance plates at each site. Audit comparisons were still calculated on the basis of a single plate, but testing all five

TABLE 3-1

ORIFICE KIT CALIBRATION

KIT # 10252

Plate No.	Press. Diff. (in H$_2$0)	Hg Difference (mm Hg)	Atm. Press. (mm Hg)	Temperature (° C)	Flowrate Incorr. (CFM)	Flowrate Corr. (CFM)
18	12.1	47	731.4	23.5	67.46	61.08
13	9.8	57	731.4	23.5	61.57	54.91
10	7.7	65	731.4	23.5	55.35	48.78
7	5.0	79	731.4	23.5	45.51	39.26
5	3.1	91	731.4	23.5	36.54	30.95

TABLE 2-2

ORIFICE KIT CALIBRATION

KIT # 10377

Plate No.	Press. Diff. (in H2O)	Hg Difference (mm Hg)	Abs. Press. (mm Hg)	Temperature (° C)	Flowrate Recorr. (CFM)	Flowrate Corr. (CFM)
10	12.5	47	731.4	23.5	67.98	61.44
13	10.0	57	731.4	23.5	61.98	55.28
10	7.8	65	731.4	23.5	55.75	49.13
7	5.0	79	731.4	23.5	45.83	39.54
5	3.2	91	731.4	23.5	36.74	31.11

TABLE 2-3

ORIFICE KIT CALIBRATION

KIT # 29069

Plate No.	Press. Diff. (in H$_2$O)	Hg Difference (mm Hg)	Atm. Press. (mm Hg)	Temperature (° C)	Flowrate Uncorr. (CFM)	Flowrate Corr. (CFM)
18	12.5	47	736	26.0	68.83	61.47
13	10.2	55	736	26.0	62.32	55.66
10	8.1	65	736	26.0	56.43	49.96
7	5.4	78	736	26.0	46.99	40.55
5	3.3	90	736	26.0	37.37	31.96

TABLE 2-4

ORIFICE KIT CALIBRATION

KIT # 20070

Plate No.	Press. Diff. (in H2O)	% Difference (mm Hg)	Atm. Press. (mm Hg)	Temperature (° C)	Flowrate Uncorr. (CFM)	Flowrate Corr. (CFM)
18	12.7	46	761	24.0	68.18	64.36
13	10.3	56	761	24.0	62.50	58.36
10	8.2	67	761	24.0	56.60	51.84
7	5.3	80	761	24.0	46.87	42.12
5	3.3	94	761	24.0	37.50	33.81

TABLE 2-5

ORIFICE KIT CALIBRATION

KIT # 20071

Plate No.	Press. Diff. (in H2O)	Hg Difference (mm Hg)	Atm. Press. (mm Hg)	Temperature (° C)	Flowrate Uncorr. (CFM)	Flowrate Corr. (CFM)
10	13.4	48	761	24.0	68.96	64.89
13	10.8	58	761	24.0	62.50	57.99
10	8.5	68	761	24.0	56.80	51.77
7	5.6	82	761	24.0	47.24	42.33
5	3.5	94	761	24.6	37.50	33.01

TABLE 2-6

ORIFICE KIT CALIBRATION

KIT # 20072

Plate No.	Press. Diff. (in H2O)	Hg Difference (mm Hg)	Atm. Press. (mm Hg)	Temperature (° C)	Flowrate Uncorr. (CFM)	Flowrate Corr. (CFM)
18	12.9	48	761	24.0	68.96	64.89
13	10.6	50	761	24.0	62.50	57.34
10	8.5	68	761	24.0	56.60	51.77
7	5.5	81	761	24.0	47.24	42.39
5	3.5	93	761	24.0	37.50	33.06

TABLE I-7

ORIFICE KIT CALIBRATION DATA

20069

Tenths of Inches H_2O

Basic Inches H_2O	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	13.0	14.5	15.5	17.0	18.0	19.0	20.0	21.0	22.0	23.0
2	23.5	24.5	25.0	26.0	26.5	27.5	28.0	28.5	29.0	29.5
3	30.0	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5
4	35.0	35.5	36.0	36.5	37.0	37.0	37.5	38.0	38.5	39.0
5	39.0	39.5	40.0	40.5	40.5	41.0	41.5	42.0	42.0	42.5
6	43.0	43.0	43.5	44.0	44.0	44.5	45.0	45.0	45.5	46.0
7	46.5	46.5	47.0	47.0	47.5	48.0	48.0	48.5	49.0	49.0
8	49.5	49.5	50.0	50.5	50.5	51.0	51.0	51.5	52.0	52.0
9	52.5	52.5	53.0	53.0	53.5	54.0	54.0	54.5	54.5	55.0
10	55.0	55.5	55.5	56.0	56.5	56.5	57.0	57.0	57.5	57.5
11	58.0	58.0	58.5	58.5	59.0	59.0	59.5	59.5	60.0	60.0
12	60.5	60.5	60.5	61.0	61.0	61.5	61.5	62.0	62.0	62.5

Readings within the matrix are the actual air flow rates corresponding to the water manometer measurements. This is an example of the matrices that were prepared for each orifice kit calibration curve.

plates minimized the possibility of error that might occur by using only one plate. The additional measurements provided additional accuracy in the audit process because, if a discrepancy arose for single plate results, complete curves could be generated for a more thorough comparison with agency calibration data.

The actual flow rate and the rotameter reading or recorder chart reading were obtained for each resistance plate. Using the orifice kit calibration data, the actual flow rate was determined from the manometer reading for the orifice pressure drop of the selected resistance plate. The rotameter or chart reading for a given resistance plate was converted to a flow rate value using the agency calibration data for that site. These two flow rates were compared, and a percent difference was calculated.

When an audit value was to be compared with an agency value for the same indicated flow rate, corrections were made for ambient temperature and pressure according to the following equation as given in the Federal Register, April 30, 1971:

$$Q_2 = Q_1 \left[\frac{T_1 P_2}{T_2 P_1} \right]^{\frac{1}{2}}$$

where: Q_2 = corrected flow rate

Q_1 = flow rate during audit as obtained from calibration kit curve

T_1 = 298°K, since orifice kit flow rates had been corrected to this volumetric equivalent for the calibration kit curve

T_i = ambient temperature at time of audit

P_i = 760 mm Hg, since the calibration kit curve had been corrected for one atmosphere of pressure

P_i = barometric pressure at time of audit

Corrections for temperature and pressure were insignificant for all locations except those at high altitudes where the barometric pressures were well below 760 mm Hg.

Barometric pressures for the sites were obtained by taking the uncorrected station pressure from the nearest weather station and correcting for the difference in altitude between the site and the weather station. Ambient temperatures were measured with a thermometer. On one series of audits, the temperatures were taken from the weather station for the same time of day as the audit because the thermometer was accidentally broken. The range of temperatures encountered in the program was sufficiently small to have no significant effect on temperature corrections.

2.4 Defects

Defects obtained from the audit results were defined by the Environmental Protection Agency. Defect limits are based as the best estimates available at this time and are to be considered only as guidelines.

Two flow rate values were obtained for the rotameter or chart reading for a given resistance plate. The actual flow rate Q_A determined from the calibrated orifice unit data was compared to the flow rate Q_R obtained from the agency data. A percent difference (d_i) was calculated as:

$$d_i = \frac{Q_B - Q_A}{Q_A} \times 100$$

A defect was defined as a percent difference greater than 6%.

2.5 Site Evaluation

A site evaluation was performed for each of the sites audited. This evaluation consisted of completing the site evaluation forms, taking photographs, and drawing maps of the surrounding area. Photographs were taken in 45° increments, but prints were developed only for the cardinal directions unless there was a significant feature at one of the 45° intervals. The site evaluation information was compiled and included in a file for each site.

A determination was also made as to whether a site met EPA siting guidelines as outlined in OAQPS 1.2-012.

2.6 Data Audits

Data processing checks were performed only in the state agency offices. The checks were made starting with the basic data and continuing through the recording of the particulate concentration in $\mu g/m^3$ on the SAROAD form. A defect was defined by EPA as a difference greater than ± 3% between the mass concentration of suspended particulates calculated by the audit check and the original concentration determined by the agency.

3.0 RESULTS

The results of the Hi-Vol audits for EPA Region VI are summarized in Table 3-1. This table includes all the sites that were listed by EPA for audits plus additional sites that were added during the program. Some of the sites on the original list had been deactivated or moved and are noted.

Subtracting the sites that were deactivated reduced the list to 203 active sites, which formed the basis of the quality assurance program. There were 32 sites at which defects of varying significance were observed; therefore, 15.8% of the sites had defects. Four sites, or 2.0% of the total sites, were inoperative when visited.

The sites were also judged on the basis of EPA siting criteria as outlined in OAQPS 1.2-0.12. The guidelines are that the sampler should be two to 15 meters above the ground and have a horizontal clearance greater than two meters. Thirty-seven sites did not meet these criteria, primarily because the samplers were located on the ground. These sites are 18% of the total.

During the data checks at the state agencies, only two defects were found in the data processing. One of these was for Site 87 and the percent difference between the audit and original values was only 3.6%. This is not a significant difference because the absolute difference between the two values was only 2 $\mu g/m^3$. For Site 66, it was found that the ambient and standard conditions were inadvertently reversed when calculating the temperature and pressure corrections for the Hi-Vol calibration. All other calibration calculations were correct. The data processing procedures for calculating particulate concentrations were checked at each agency and found to be correct.

TABLE 3-1

RI-VOL AUDIT RESULTS

SITE NUMBER	MEET EPA SITING CRITERIA	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	PERCENT DIFFERENCE	AUDIT	COMMENTS
1	Yes	55.9	58.0	+3.7%		
2	Yes	53.8	51.7	-3.9%		
3	Yes	54.3	53.5	-1.47		
4	Yes	51.8	52.3	+0.97		
5	Yes	53.6	52.1	-2.8%		
6	Yes	55.3	53.9	-2.5%		
7	Yes	53.4	55.0	+3.0%		
8	Yes	49.5	38.7	+25.5	Yes	Note 1
9	Yes	45.8	44.8	-2.2%		
10	Yes	49.3	51.4	+4.3%		
11	Yes	49.3	51.0	+3.45		
12	Yes	45.3	42.5	-6.1%		
13	Yes	51.8	54.8	+5.7%		
14	Yes	56.5	61.8	+9.3%	Yes	Note 1
15	Yes	53.8	54.7	+1.6%		
16	Yes	56.0	55.3	-1.2%		
17	Yes	52.9	51.4	-2.8%		
18	Yes	52.9	54.0	+2.0%		

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, lb	AGENCY FLOW, lb	PERCENT DIFFERENCE	[illegible]	[illegible]	COMMENTS
19	No	40.0	41.7	+4.00	Yes		Notes 1 and 2
20	No	42.5	45.4	+7.40	Yes		Notes 1 and 2
21	Yes	39.0	41.0	+5.17			
22	Yes	45.0	48.3	+7.33	Yes		Note 1
23	No	47.5	50.1	+5.47			
24	Yes	45.5	46.8	+2.86			
25	Yes	38.5	40.0	+1.3b			
26	No	39.0	40.6	+4.10			Note 2, calibration curves diverge at high flow rates
27	—	———	———	———			Deactivated
28	Yes	49.0	50.1	+2.24			
29	Yes	42.5	48.9	+15.1	Yes		Note 1
30	Yes	46.0	48.7	+5.87			
31	Yes	47.8	47.1	-1.46			
32	Yes	50.5	51.9	+2.77			
33	Yes	51.0	53.1	+4.12			
34	Yes	47.0	48.4	+2.98			
35	Yes	47.4	50.1	+5.70			

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, lb	AGENCY FLOW, lb	PERCENT DIFFERENCE	DEFECT	COMMENTS
36	Yes	45.0	47.2	+4.98		
37	---	----	----	----		Decertified
38	Yes	46.5	48.6	+4.52		
39	Yes	47.5	48.6	+2.32		
40	Yes	42.4	57.4	+34.5	Yes	Note 1
41	Yes	47.5	49.5	+4.21		
42	No	42.5	45.0	+5.88		Note 2
43	Yes	48.5	50.6	+4.37		
44	No	50.0	51.1	+2.20		Note 3
45	Yes	47.5	49.6	+4.42		
46	No	48.0	48.6	+1.38		Note 2
47	No	41.5	43.8	+5.54		Note 2
48	No	48.5	50.0	+3.09		Note 2
49	Yes	----	----	----		Unable to schedule
50	Yes	44.2	45.9	+3.85		
51	No	47.5	48.4	+1.89		Note 4
52	No	44.0	45.6	+3.64		Note 2
53	No	49.0	51.2	+4.49		Note 2

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SIZING CRITERIA	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	PERCENT DIFFERENCE	DEFECT	COMMENTS
54	Yes	47.0	48.9	+4.04		
55	---	---	---	---	---	Inoperative
56	Yes	43.5	45.9	+5.52		Curves diverge at high flows
57	Yes	48.4	50.2	+3.72		
58	Yes	42.4	45.8	+8.13		4 months since calibration
59		48.8	44.5	-9.19	Yes	4 months since calibration
60	Yes	43.5	41.0	-5.75		
61		47.9	49.3	+2.92		
62	Yes	46.9	52.0	+11.1	Yes	4 months since calibration
63	Yes	54.8	57.8	+5.56		
64	Yes	56.1	58.0	+3.39		
65	---	---	---	---	---	Notes
66	Yes	55.8	61.8	+8.32	Yes	Notes 6 and 7
67	Yes	67.1	73.8	+8.74	Yes	Note 6
68	Yes	51.4	58.8	+13.7	Yes	

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA?	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	PERCENT DIFFERENCE	AFFECT	COMMENTS
69	Yes	52.8	54.7	+3.6%		
70	Yes	54.9	60.3	+9.8%	Yes	
71	Yes	47.9	50.0	+4.3%		
72	Yes	65.5	68.7	+4.5%		
73	—	—	—	—	—	Note 5
74	Yes	60.6	70.0	+15.5	Yes	Note 6
75	Yes	51.5	54.0	+4.8%		
76	Yes	40.6	50.3	+23.1	Yes	Note 6
77	Yes	64.0	64.0	0		
78		47.9	40.5	-15.4	Yes	
79	Yes	65.3	67.0	+2.6%		
80	Yes	44.8	44.2	-1.3%		
81	No	—	—	—		Inoperative; filled with soil on ground and beneath a tree
82	Yes	45.9	46.8	+1.9%		
83	Yes	49.8	49.5	-0.6%		
84	Yes	43.8	70.0	+59.7	Yes	
85	Yes	50.3	49.5	-1.5%		

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, Qa	ASSIGNED FLOW, Qa	PERCENT DIFFERENCE	DEFECT	COMMENTS
86	Yes	47.7	49.5	+3.77		
87	Yes	48.4	38.0	-5.54		
89	Yes	47.9	48.0	+0.21		
89	---	---	---	---		Only 01-Vol P90 at site instead of two as indicated in audit list.
90	Yes	46.7	45.3	-3.00		
91	Yes	43.6	49.5	+13.5	Yes	
92	Yes	45.0	46.0	+0.44		
93	Yes	48.7	48.0	-1.43		
94	Yes	45.1	45.5	+0.89		
95	Yes	41.0	37.0	-11.5	Yes	
96	Yes	48.2	47.0	-2.49		
97	Yes	47.9	45.0	+6.05		
98	Yes	50.5	48.0	-4.95		
99	Yes	43.5	44.6	+2.53		
100	Yes	44.1	46.0	+3.06		
101	Yes	49.4	44.0	+5.17		

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	PERCENT DIFFERENCE	REJECT	COMMENTS
102	Yes	49.0	50.5	+3.06		
103	Yes	48.0	49.0	+2.08		
104	No	48.0	49.0	+2.08		Note 2
105	Yes	45.0	45.5	+1.11		
106	----	----	----	------		Deactivated
107	Yes	49.0	47.5	-3.06		
108	Yes	49.5	48.0	-3.03		
109	Yes	48.0	49.0	+2.08		
110	Yes	44.0	47.0	+6.36		
111	Yes	49.0	47.0	-4.08		
112	Yes	48.0	48.7	+1.46		
113	Yes	38.4	36.0	-6.25	Yes	Note 9
114	Yes	42.4	32.5	-23	Yes	Note 10
115	Yes	49.7	48.0	-3.42		
116	Yes	50.5	48.0	-4.95		
117	Yes	47.0	48.5	+3.19		
118	Yes	47.4	46.0	-2.95		
119	Yes	39.7	37.5	-5.54		

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	DIFFERENCE	DIPSLT	COMMENTS
120	Yes	49.3	45.0	-4.91		
121	Yes	50.0	46.0	-4.00	Yes	
122	Yes	48.0	50.0	+4.17		
123	Yes	48.6	54.0	+11.1	Yes	
124	No	43.6	46.5	+7.35		Note 1
125	No	45.5	47.0	+4.40		Note 2
126	Yes	44.6	45.5	+2.02		
127	Yes	47.9	48.0	+0.21		
128	Yes	51.5	54.0	+4.37		Notes 11 and 12
129	Yes	53.3	50.5	-5.35		Note 9
130	Yes	46.4	48.5	+4.52		
131	No	58.3	59.0	+1.20		Note 13
132	Yes	59.9	62.3	+3.50		
133	Yes	57.1	55.0	-3.85		
134	Yes	54.6	54.0	-1.10		
135	Yes	65.1	66.0	+1.34		
136	Yes	47.9	52.0	+8.56	Yes	
137	Yes	62.3	62.0	-0.48		

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, %	ACCEPT FLOW, %	PERCENT DIFFERENCE	REJECT	COMMENTS
138	No	47.5	50.0	+4.88		Note 2
139	No	58.0	59.5	+1.19		Note 2
140	Yes	62.5	64.2	+2.72		
141	Yes	39.7	42.5	+7.05	Yes	
142	Yes	47.3	47.0	-0.63		
143	Yes	46.7	52.0	+12.9	Yes	
144	Yes	49.0	46.5	-5.10		
145	No	45.0	44.0	-2.22		Note 2
146	No	49.5	48.5	-2.02		Note 2
147	No	44.2	39.7		Yes	Notes 2 and 14
148	Yes	30.6	29.0	-6.50	Yes	Note 14
149	Yes	50.5	50.0	-0.99		
150	Yes	48.6	45.0	-1.43		
151	---	---	---	---	---	Deactivated
152	Yes	38.0	41.0	+7.89	Yes	
153	Yes	43.5	44.5	+2.30		
154	Yes	47.6	45.0	-5.46		
155	Yes	44.0	42.5	-3.41		

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	PERCENT DIFFERENCE	AUDIT	COMMENTS
156	Yes	45.9	46.8	+0.22		
157	---	----	----	----		Deactivated
158	Yes	47.3	52.0	+9.9%	Yes	Note 1
159	No	45.5	44.5	-2.38		Note 2
160	Yes	45.5	45.0	-1.38		
161	Yes	46.5	45.0	-3.23		
162	No	46.5	45.0	-3.23		Note 2
163	---	----	----	----	---	Deactivated
164	Yes	46.3	48.7	+5.18		
165	Yes	42.5	43.5	+2.35		
166	No	47.4	46.0	-2.95		Note 2
167	Yes	58.4	47.5	-5.75		
168	Yes	47.6	48.5	+1.89		
169	Yes	45.7	48.5	-1.75		
170	Yes	44.2	45.0	-1.81		
171	No	46.1	48.0	4.12		Note 2
172	---	----	----	----	---	Deactivated
173	No	43.5	46.0	5.75		Note 2

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, Gpm	AGENCY FLOW, Gpm	PERCENT DIFFERENCE	REFACT	COMMENTS
174	No	47.4	47.0	-0.84		Note 2
175	No	47.0	46.0	-2.13		Note 2
176	Yes	46.0	45.0	-1.85		
177	Yes	46.3	47.5	+1.66		
178	Yes	46.1	46.0	-0.22		
179	No	42.0	41.0	-4.11		
180	No	44.0	44.5	+1.14		Note 2
181	—	——	——	——		Deactivated
182	Yes	48.9	46.0	-5.90		
183	Yes	52.0	51.0	-1.92		Note 15
184	——	——	——	——		Deactivated
185	No	46.4	46.0	-0.86		Note 2
186	Yes	45.6	48.0	+5.26		
187	Yes	47.0	48.5	+1.66		
188	Yes	47.5	48.5	+6.71		
189	Yes	49.0	45.0	-8.16	——	
190	——	——	——	——	——	Note 16
191	Yes	46.0	44.9	-3.65		

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	PERCENT DIFFERENCE	BIAS?	COMMENTS
192	Yes	46.8	44.4	-4.72		
193	Yes	46.4	46.5	+0.22		
194	Yes	43.6	43.5	-0.23		
195	---	---	---	---	---	Deactivated
196	No	44.4	46.8	+3.60		
197	Yes	40.5	35.0	-13.6	Yes	
198	---	---	---	---	---	Deactivated
199	Yes	44.4	45.0	+1.35		
200	Yes	47.4	50.0	+5.49		
201						
202	No	44.0	46.5	+5.70		Note 2
203	Yes	47.7	49.0	+2.73		
204	Yes	48.0	49.0	+2.15		
205	Yes	48.5	46.0	+5.67		
206	Yes	47.1	49.0	+3.87		
207	No	46.7	45.5	-1.52		Note 17
208	No	45.5	46.0	+1.10		Note 2
209	No	---	---	---	---	Inoperative and Note 2

Table 3-1 (Cont'd)

SITE NUMBER	MEETS EPA SITING CRITERIA	ACTUAL FLOW, Qa	AGENCY FLOW, Qa	PERCENT DIFFERENCE	AGENCY	COMMENTS
210	—	———	———	———		Deactivated
211	Yes	42.8	42.3	+0.75		Note 10
212	Yes	48.8	43.8	+5.39		
213	Yes	47.3	46.5	-1.69		
214	Yes	45.2	46.5	+2.88		
215	Yes	47.7	49.8	+2.90		
216	Yes	45.8	45.0	-1.72		
217	Yes	46.7	48.8	+2.78		

NOTES FOR TABLE 3-1

NOTE 1 The audit and agency curves are parallel.

NOTE 2 The site does not conform to EPA criteria because the sampler is located on the ground.

NOTE 3 The site does not conform to EPA criteria because the sampler is located on the ground and too near a fence.

NOTE 4 The site does not conform to EPA criteria because the sampler is located on the ground and enclosed by a fence.

NOTE 5 Calibration data was not supplied by the agency.

NOTE 6 The calibrations of these sites were performed using an orifice kit which is believed to be incorrectly calibrated.

NOTE 7 The agency calibration data for this site were for a calibration that was performed after the audit.

NOTE 8 Only one Hi-Vol was at the address, but two Hi-Vols were noted on the list of sites to be audited.

NOTE 9 State Hi-Vol co-located with local Hi-Vol.

NOTE 10 City Hi-Vol co-located with state Hi-Vol. The calibration data provided was for a calibration after the audit.

NOTE 11 The audit and calibration curves cross but diverge significantly at extreme values.

NOTES FOR TABLE 3-1 (Continued)

NOTE 12 City Hi-Vol co-located with state Hi-Vol.

NOTE 13 This site does not meet EPA criteria because the Hi-Vol is near to an air conditioner unit approximately as tall as it.

NOTE 14 The audit and calibration curves intersect at the low end but diverge at high flow rates.

4.0 DISCUSSION AND SUMMARY

The quality assurance study on the total suspended particulate programs in EPA Region VI indicated that the agencies are performing all functions according to the prescribed procedures. Relatively good agreement with the audits was achieved considering the precision of the method employed to measure particulate concentrations.

The most obvious sources of differences between audit values and agency calibration values were:

- Elapsed time between audit and calibration
- Uncalibrated orifice kits

Some audits were conducted four or more months after an agency calibration and were outside the defect limits. These differences could be due to wearing of the brushes or changes in the recording mechanism. The defects in one series of audits could be traced to an agency orifice kit that appeared to be out of calibration. The suspect kit gave erroneous results on all audits while other kits from the same agency gave close agreement with the audit results. This comparison was possible because Radian used the same audit kit on all calibration checks at the respective agency. Other errors may be due to orifice kits that need recalibration, but the agency data, depending on the presentation, did not always identify which orifice kit was used to calibrate the Hi-Vols.

The results presented in Table 3-1 are for resistance plates that give a flow rate of 38 cubic feet per minute (ft^3/min) or greater. These flow rates are in the range that should be

encountered during sampling. Low flow rates cannot be measured accurately. The Federal Register recommends that the flow rate be approximately 40 to 60 ft^3/min. Resistance plate number five gives flow rates that are below acceptable levels for audits and usually is not on the linear portion of a calibration curve produced by using all five resistance plates.

The defect limit defined by EPA for the Hi-Vol audits was 6%. As the flow rate of the sampler decreases, the percent difference for a constant absolute difference in flow rates increases sharply. As an example, a constant difference of two ft^3/min between agency and audit flow rates would yield percent differences of 3.3% and 6.6%, respectively, at 60 and 40 ft^3/min. Table 4-1 summarizes the range of differences encountered in this program for each resistance plate. The percent differences in the audit results are broken down into four ranges and the fraction of sites that fall into each range are given for each resistance plate. The table illustrates the large variations with the orifice plates at low flow rates.

Most Hi-Vol sites that did not meet EPA siting guidelines failed because the samplers were mounted on the ground. The basis for deciding if a site met EPA criteria was the EPA document "Guidance for Air Quality Monitoring Network Design and Instrument Siting," OAQPS No. 1.2-012, September, 1975. The criteria for monitoring different pollutants are summarized in Table II-3 of the above document. The guidelines for siting Hi-Vol samplers is shown in Table 4-2.

The guidelines specify that samplers should be two to 15 meters above the ground to prevent the capture of re-entrained dust. All agencies should continue to re-evaluate their monitoring sites with respect to changing EPA guidelines in siting monitors.

TABLE 4-1

RANGE OF PERCENT DIFFERENCES IN
AUDIT RESULTS AS A FUNCTION OF RESISTANCE PLATE

Resistance Plate No.	Fraction of Sites in Each Range of Percent Differences			
	0 to ±6%	±6% to ±10%	±10% to ±15%	>±15%
5	0.27	0.13	0.16	0.44
7	0.53	0.18	0.14	0.15
10	0.68	0.15	0.10	0.07
13	0.76	0.12	0.10	0.02
18	0.78	0.08	0.10	0.04

TABLE 4-2

GUIDELINES FOR PROBE PLACEMENT

Pollutant	Site Type	Height Above Ground	Vertical Clearance	Horizontal Clearance
Suspended Particulates	Peak	2 to 15 meters	--	>2 meters
	Neighborhood	2 to 15 meters	--	>2 meters
	Background	2 to 15 meters	--	>2 meters

Some samplers are marginal because of their relative proximity to roads, exhaust vents, and potential wind obstructions.

All the state agencies in EPA Region VI process their raw Hi-Vol data according to EPA guidelines. The fact that there are few errors attests to the uniformity of and adherence to strict guidelines. The agencies have established their processing schemes to handle the data in an orderly, efficient manner. Most of the agencies are computerizing their processing which results in increased accuracy and consistency. Calibration data is computed and organized into either tables or graphs of Hi-Vol true flows versus Hi-Vol flow indicator responses. Two other factors that contribute to the accuracy of the data processing are (1) the simplicity of the procedures and (2) the experience of the personnel. Hi-Vol data reduction is a straightforward process that is not subject to the technique and interpretative problems associated with reducing strip chart data for continuous analyzers. Agency personnel have worked with Hi-Vols longer than any other type of monitoring equipment and have established the routines necessary to achieve accurate data reduction.

In addition to their own network of samplers, state agencies accept data from city and county agencies. These agencies establish their own networks, reduce the raw data, and provide data to the state agencies for the state's ambient air data bank.

The results of the quality assurance program can be summarized as follows:

- All agencies conduct measurements and processing according to Federal Register procedures and EPA guidelines.

- 205 sites were audited.
- 15.6 percent of the sites had defects.
- 2.0 percent of the sites were inoperative.
- 18 percent of the sites did not meet EPA siting criteria.

SITE EVALUATION FORM

Sample Checklist

1. Objective for Monitoring

2. The Type of Station

3. Location of the station (site categories and physical location):

   a. Urban (high density pop.)_____low density pop.)_____
      1. Commercial (high density) _____(low density) _____
      2. Industrial (high density) _____(low density) _____
      3. Residential _____

   b. Surburban (high density pop.) _____(low density pop.) _____
      1. Commercial _____
      2. Industrial _____
      3. Residential _____

   c. Rural (high density pop.) _____(low density pop.) _____

   d. EPA Region _____State_____SMSA _____
      AQCR _____County _____
      City _____Address (map in Appendix)_____
      _____
      UTM Coordinates _____Height above ground_____

4. Pollutant Source
   a. Commercial _____Type_____Distance From Probe _____tons/yr _____
   b. Industrial _____Type _____Distance From Probe _____tons/yr_____

5. Topography Type & Size - Proximity Orientation

   a. Isolated Hills:

   b. Isolated Valleys:

   c. Bodies of Water:

   d. Bodies of Trees:

   e. Terrain (check one) generally smooth _____, or rough _____.

   f. Picture of 360° view from the probe of the monitoring site.

6. Atmospheric Ventilation:

   a. Generally Good
   b. Generally Restricted
   c. Directionally Biased Direction:
   d. Interferences to Normal Air Flow: (Buildings, Hills, Trees, Streets, etc)

      Type & Size:

      Proximity:

Siting for the Station and Air Inlet

Pollutant Category	Pollutant	Station Location	Position of Air Inlet		
			Supporting Structure	Vertical Clearance Above Supporting Structure, Feet	Horizontal Clearance Beyond Supporting Structure, Feet